I. Introduction
Climatic Similarity: The current martian climate is hyper-arid and hypothermal, similar to the climate of the Antarctic McMurdo Dry Valleys (MDV) [1].

Hydrogeologic Similarity and Climate Modelling: Geologic evidence, including the widespread fluvial valley networks (MVN) [2] and lakes [3], suggest that Late Noachian and Early Hesperian (~3.7Ga) climate may have been much different than today, with abundant liquid water [4] forming fluvial and lacustrine features. In contrast to this geologic evidence, climate models suggest that the early martian climate may have been "cold and icy", characterized by mean annual temperatures far below the melting point of water (~225 K), an adiabatic cooling effect [5], and ice distributed across the southern highlands [6].

Role of Climate in the Formation of Features: In this scenario, transient or punctuated heating events produce melt required to form these features [7]; one such process is seasonal temperature variation producing summertime melt [8]. Thus, it is possible that early Mars was similar to today's MDV in temperature and melt-related fluvial processes.

MDV as a Process-Based Analog: As here we consider the MDV as an analogue for early Mars to better understand the role of ice melting and runoff in a "cold and icy" environment. We compare geomorphological and meteorological characteristics in the MDV with the MVN.

II. Methods
Systematic evaluation of the Onyx River in the MDV provides insights into the possible fluvial feature formation fed by glacial meltwater in a cold and icy climate. Our comparison of the MDV to the MVN may suggest whether the MVN formed in a similar climatic scenario through similar fluvial processes.

1. Cambor photography of LiDAR imagery (~0.5m/pixel) from 18-29 December 2001 was stitched together in Adobe Photoshop and exported as .tif to ArcGIS. This process was: Load Files into Stacks -> Auto Align Layers -> Auto Blend Layers to yeild seamless mosaics [17].
2. Stitched Cambor .tiff images were georeferenced to -> Auto Blend Layers to yeild seamless mosaics [17].
3. Polylines were produced similarly to previous work of the above Cambor imagery [2].
4. Long-Term Ecological Research (LTER) meteorological data is compared to the influence of solar radiation, air temperature, and relative humidity on discharge rates in a typical (2000-01) and atypical (2003-04) season. Solar radiation varies from 0 to 900 W/m². Air temperature varies from -50 to 10°C. Precipitation events occur over the course of the year but do not influence discharge. Average discharge rates are 0-0.5 m³/s. We find that temperatures resulting in river formation in MDV are similar to those modelled for MVN formation [1]. This implies that the process of seasonal melt may have supported "cold and icy" MVN formation.

III. Results

1. Results Study Area

Study Area

The Onyx River is located within the MDV, Antarctica.

Multiple glacial tributaries (shown as triangles above) contribute meltwater to the Onyx River. The Onyx is the output of Lake Brownworth which then fills Lake Vanda. Lake Brownworth is an open-basin lake contained to the east by cold-based Lower Wright Glacier and to the west by a terminal glacial moraine. Lake Vanda is a closed-basin lake.

The river meanders near Lake Brownworth down high slopes and then transitions into broad braided channels.

IV. Conclusions

• Annual summertime sublimation and top-down melting form inlet channels within the MDVs that enter the Onyx River.
• The headwaters of the Onyx River accumulate annually in Lake Brownworth off of Lower Wright Glacier. Tributaries from other glaciers flow along the ice table as marginal wettings and streams that also contribute to the river.
• A terminal moraine is significant to the yearly formation of the Onyx River.
• Temperature and solar radiation are important to discharge rates in time, which is likely not as important for precipitation-fed rivers.
• Relative humidity and precipitation is not important to discharge rates in time.
• Thus, if the MVN formed in a temperature environment similar to the MDV, the structure of the MVN may have been largely controlled by infrequent unusually warm years that result in increased discharge rates.
• ~87% of the MVN have Strahler stream orders less than or equal to the Onyx at a similar spatial resolution to the MVN.
• The water availability, sources and sinks, and general climate conditions during the MVN formation may be similar to the MDV.
• MVN formation does not preclude a "cold and icy" climate hypothesis.

References


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